REMARKS

Applicants acknowledge receipt of an Office Action dated June 5, 2006. In this response Applicants have amended claims 1, 10, 15, 18, 21, 24 and 25. Claim 12 has been canceled without prejudice or disclaimer. Support for the amendments to claim 1 can be found at least in the specification on page 4, lines 22-24, and page 10, lines 3-15. Support for the amendments to claim 10 can be found at least in original claim 12, and in the specification on page 10, lines 3-15. Support for the amendments to claims 18, 24 and 25 can be found at least in the specification on page 10, lines 3-15. Support for the amendments to claims 15 and 21 can be found at least in the specification on page 16, lines 14-16. Following entry of these amendments, claims 1, 3, 5-10, 14-18, and 20-25 are pending in the application. The specification has been amended to correct clerical errors in Tables 5 and 6.

Reconsideration of the present application is respectfully requested in view of the foregoing amendments and the remarks which follow.

Rejections Under 35 U.S.C. § 112

Claims 1, 3, and 5-9 stand rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement.

Specifically, the Office Action stated on page 2:

> The expressions "at least some Ta" and "at least some oxygen" in claim 1 do not have literal support from the specification as originally filed. The support relied upon by applicant in page 4, lines 20-24 below does not literal[ly] support said expressions. The dispersion ±80% as recited in [the] specification also includes zero.

Applicants submit that the expressions "at least some Ta" and "at least some oxygen" in claim 1 are fully supported by the application as originally filed. Both Ta and oxygen are <u>inherently</u> contained as inevitable impurities in a Nb sputtering target. For example, with respect to oxygen, and as noted during prosecution of this application, <u>one of ordinary skill in the art</u> would readily recognize from the disclosure as originally filed, that oxygen is an <u>inevitable</u> impurity, and thus there is support for claiming "at least some oxygen." As noted in the Declaration by one of the inventors, Koichi Wantanabe, under 37 C.F.R. 1.132 filed in

the present application on April 12, 2004, JP 62-103335 demonstrates that oxygen exists as an impurity in Nb even for super high purity Nb produced by high quality manufacturing methods. One of ordinary skill in the art would reasonably interpret claim 1 as requiring some amount of oxygen impurity as evidenced by JP 62-103335, because that impurity exists even in super high purity Nb. Finally, applicants note that all the examples disclosed in the present application for the oxygen effect study (see Table 3 on page 25) exhibit at least some oxygen. In sum, one of ordinary skill in the art would interpret the original disclosure as filed as supporting "at least some oxygen" in claim 1.

Further, Ta and oxygen as inevitable impurities in a Nb sputtering target have a relationship with each other. The specification on page 7, line 23 to page 8, line 1, notes that Ta (which is also an inevitable impurity) is easily oxidized, and thus one of ordinary skill in the art would recognize that oxygen must also be an inevitable impurity. The specification also describes the close connection between Ta and oxygen, i.e., the coexistence of Ta and oxygen in a high purity Nb sputtering target, in detail. For example, in the specification from page 4, line 25 to page 5, line 19, it is disclosed that oxygen as an impurity is closely related with an oxide of Ta (Ta_2O_5). Further, on page 15, lines 13 to 19, it is particularly described that a step of melting due to EB, with the intention of reducing the Ta content and the dispersion thereof, and further with an intention of reducing the oxygen content and the dispersion thereof, is repeated multiple times. Accordingly, since it is clear that Ta and oxygen coexist as inevitable impurities in the sputtering target in the specification, one of ordinary skill in the art would find that the the expressions "at least some "Ta" and "at least some oxygen" in claim 1 are fully supported in the specification as originally filed.

Moreover, applicants note that the test for written description support is <u>not express disclosure</u> in the specification, but whether one of ordinary skill in the art would recognize the inventor to be in possession of the invention as claimed. In the present case, based on the discussion above that Ta and oxygen are inevitable impurities in a Nb sputtering target, one of ordinary skill in the art would understand that the high purity Nb sputtering target of claim 1 must contain at least some Ta and at least some oxygen. Further, the written description requirement standard is directed to a person skilled in the art, and such person would clearly

understand the disclosure of the present invention as involving non-zero amounts of Ta and oxygen, i.e., the claim can not be read in a vacuum divorced from the real world.

In view of the forgoing comments, applicants respectfully request that the rejections under 35 U.S.C. 112, paragraph 1 be withdrawn.

Claims 1, 3 and 5-9 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention.

Specifically, the Office Action stated on page 2:

> Claim 1 is indefinite because the wording "some" in lines 3 and 4 fails to define [a] specific amount.

Applicants submit that the term "some" in lines 3 and 4 of claim 1, is definite in that the term merely conveys an existence of an amount greater than zero. Therefore, the wording "at least some amount" clearly and definitely expresses the existence of the impurities Ta and oxygen in an amount greater than zero. Accordingly, applicant respectfully requests that the rejection under 35 U.S.C. 112, second paragraph be withdrawn.

Rejections Under 35 U.S.C. § 103

Claims 1, 3-10, 12, 14-18 and 20-23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,693,203 to Ohhashi et al. (hereafter "Ohhashi") in view of applicants' alleged admission in the Rule 132 declaration filed on April 12, 2004. Claims 24-25 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ohhashi in view of acknowledged prior art on page 2, lines 1-24 (hereafter "the APA"). Applicants respectfully traverse these rejections for at least the following reasons.

Claims 1 and 18

Claims 1 and 18 are each directed to a high purity Nb sputtering target. Claim 1, as amended recites:

> A high purity Nb sputtering target containing an amount of Ta and an amount of oxygen as impurities dispersed therein, the *amount of Ta in the target being 3000 ppm or less*, the target containing at least some Ta, the *amount of oxygen in the target being 200 ppm or less*, the target containing at least some oxygen, wherein a *dispersion of the Ta content in the target is within 30%*, and a *dispersion of the oxygen content in the target is within 80%*, the dispersion of the Ta content and the dispersion of the oxygen content being respectively defined by the following equation, for respective measured content values of 9 specimens sampled at respective predetermined positions in the target:
> dispersion (%) = {(maximum value - minimum value) / (maximum value + minimum value)} X 100.

Claim 18 recites:

> A high purity Nb sputtering target consisting essentially of Nb containing an amount of oxygen as an impurity dispersed therein, the *oxygen content in the target being 200 ppm or less*, the target containing at least some oxygen, wherein a *dispersion of the oxygen content in the target is within 80%*, the dispersion of the oxygen content being defined by the following equation, for respective measured content values of 9 specimens sampled at respective predetermined positions in the target:
> dispersion (%) = {(maximum value - minimum value) / (maximum value + minimum value)} X 100.

Thus, claim 1 recites an amount of Ta less than 3000 ppm, a Ta content dispersion within 30%, an amount of oxygen less than 200 ppm, and an oxygen content dispersion within 80%, while claim 18 recites an amount of oxygen less than 200 ppm and an oxygen content dispersion within 80%.

The claimed content and dispersion is <u>not</u> disclosed in Ohhashi

Ohhashi does <u>not</u> suggest a Nb sputtering target with the Ta amount, Ta dispersion, oxygen amount or oxygen dispersion of claim 1, or the oxygen amount or dispersion of claim 18. Ohhashi does <u>not</u> discuss the presence of Ta or oxygen impurities in his sputtering target. In the Ohhashi disclosure, Nb is merely enumerated as one of various metal materials for sputtering targets. Ohhashi does not disclose <u>any</u> specific examples relating to a <u>Nb</u> target, instead, Ohhashi discloses a high purity <u>tungsten</u> sputtering target (example 5) and a high purity <u>titanium</u> sputtering target (example 6). Ohhashi does not deal with the existence of Ta

or oxygen in a Nb target nor does Ohhashi recognize the problems caused thereby, much less the specific amounts and dispersion characteristics recited in claims 1 and 18.

Ohhashi, which merely discloses examples of tungsten and titanium sputtering targets, fails to teach or suggest any specific problems relating to impurities of Ta and/or oxygen specifically in a Nb target, and in particular the Ta content and oxygen content and the dispersions thereof, which are subject matter of claims 1 and 18. Ohhashi's disclosure of examples of Ti or W sputtering targets do not suggest the problems with Ta or oxygen impurities in a Nb sputtering target. In general, the purity of marketed high purity metal Ti or W is considered to be 5N, while the purity of marketed high purity metal Nb is 4N. In the case of Nb, even in high purity Nb metal, a larger amount of impurities, such as oxygen and Ta, are contained therein as compared with high purity W or Ti. In particular, as described in the specificaion on page 7, lines 16 to 22, both Nb and Ta belong to the 5A group elements in the Periodic Table. Accordingly, Nb easily contains at least some amount of Ta. This problem causes a peculiar problem for Nb sputtering targets. Ohhashi, which merely provides specific examples of W or Ti sputtering targets, does not recognize the above problem in a Nb sputtering target, and does not suggest any specific amounts or dispersion of Ta or oxygen in a Nb sputtering target.

The claimed amount and dispersion is <u>not</u> inherent in Ohhashi

The recited amount and dispersion levels of Ta and oxygen in claims 1 and 18 are <u>not inherent</u> in Ohhashi. To establish inherency, the Patent Office must show that a claimed feature is <u>necessarily</u> present in a reference. In the present case, the Patent Office has not met its burden of showing that the amount and dispersion levels of the inevitable impurities Ta and oxygen recited in claims 1 and 18 are <u>necessarily</u> present in the Nb sputtering target disclosed in Ohhashi.

To the contrary, applicants have shown that the Ta and oxygen amounts and dispersion recited in claims 1 and 18 are <u>not</u> inherent in Nb sputtering targets. Applicants provide, as evidence that proves lack of inherency, examples from the present specification

which disclose some Nb sputtering targets having Ta and oxygen with amounts and dispersion outside the range recited in claim 1 and 18.

The Office Action states on page 5:

> [I]f the dispersion is uniform (maximum value equal minimum value), then the dispersion is zero. Ohhashi discloses target having uniform microstructure (col. 6, line 42) and with no or little diffusion of their constituent atoms (col. 6, lines 57-58).

As discussed above, however, Ohhashi does not recognize the specific problems with inevitable Ta or oxygen impurities in a Nb target. Ohhashi's disclosure of a uniform microstructure for the grains of his sputtering target with little diffusion for the atoms of the grains does not suggest what the amount or dispersion may be for Ta or oxygen impurities in a Nb sputtering target. Merely because the grains are uniform in microstructure does not suggest that the impurities in the targets have a uniform distribution, and thus does not suggest a dispersion near zero. Moreover, a uniform dispersion merely means that the dispersion is constant, not that the dispersion is zero.

One of ordinary skill in the art would recognize that a dispersion of zero is not inherent in Ohhashi

The Office Action states on pages 3-4:

> Ohhashi does not disclose O and Ta contents. But applicants' admission in Rule 132 declaration, items 3-4 acknowledges that Ta and O are inevitable purities that exist even in high purity Nb sputtering target. In view of applicant's admission, ordinary skill artisan would recognize Nb sputtering target of Ohhashi would inherently possess Ta and O as inevitable impurities. Since Ta and O are inevitable impurities, their dispersion would be uniform in Nb sputtering target. Thus, the dispersion % of said O and Ta is zero.

While applicant's agree that one of ordinary skill in the art would recognize that Ta and oxygen are inevitable impurities in a Nb sputtering target, no one prior to Applicants recognized the effect of those impurities. Further, it is not the case that the dispersion % of oxygen and Ta in such a target is inherently zero. Again, applicants point to the many

examples of a Nb sputtering target in the present specification where the dispersion % of oxygen and Ta is not zero.

Generally, the content of the impurities in a metal is obtained by measuring the content at several points in a sample, such as by the method disclosed in the present specification (as described on page 10, lines 3 to 15 of the present specification, for example, the dispersion of Ta content may be determined by measuring respective Ta content values of specimens sampled from 9 different points of the sputtering target). Accordingly, even if the content of such impurities is small, one of ordinary skill in the art would readily recognize that the dispersion necessarily exists between content values of impurities at measured points. The dispersion % of content values as defined in the claims is determined by the equation (maximum value - minimum value)/(maximum value + minimum value) x 100 (%). Therefore, it would be impossible to obtain a dispersion of 0 unless all measured 9 content values have the same value.

Moreover, the Patent Office has provided <u>no evidence</u> that the distribution of the inevitable impurities Ta and oxygen in a Nb sputtering target would be uniform, such that the dispersion % of these impurities are zero. To the contrary, the many examples of non-zero dispersion % in the present specification clearly suggests that a zero dispersion % of oxygen and Ta in Nb sputtering targets is not inherent. Merely because an element is an impurity does not suggest that it has a uniform distribution. <u>If the Examiner maintains this contention, applicants respectfully request the Examiner to provide evidence supporting his contention.</u>

Ohhashi is silent regarding the dispersion of inevitable Ta and O impurities in his sputtering targets, and the dispersion range recited in the claims is not inherent in the Ohhashi targets. Ohhashi's sputtering target may contain amounts of Ta and/or oxygen that are above the upper limits of claims 1 and 18, and the dispersion values are incapable of being known based on the Ohhashi disclosure. Thus, the sputtering targets as claimed in claims 1 and 18, respectively, with the recited Ta and oxygen amounts and dispersion, are not described in Ohhashi. That is, claims 1 and 18 do not read on any sputtering targets that are either identically described or disclosed in Ohhashi, nor upon any such targets that are taught or suggested by Ohhashi.

The Patent Office has not met its burden in establishing inherency in Ohhashi

The Office Action states on page 5:

> [A]pplicants fail to substantiate the dispersion of Ta and O in sputtering target of Ohhashi are non-uniform,

and on page 6:

> there is no evidence that the Ta impurity in Ohhashi is over 3000 ppm. Examples in instant specification are intentionally adding Ta and O.

Applicants note, however, that the burden is upon the Patent Office to reasonably establish inherency, which the Patent Office has not met. Moreover, to the extent that the Patent Office can arguendo be considered to have raised a reasonable doubt as to whether Ohhashi may inherently disclose a uniform dispersion of these impurities, as discussed above, applicants have shown by evidence that the amount and dispersion levels of Ta and oxygen claimed are not inherent in Nb sputtering targets.

Moreover, the Office Action characterization that Ta and oxygen are "intentionally added" in the specification is not accurate to the extent that Ta and oxygen are inevitable impurities which are necessarily present. The examples provided in the specification are reflective of normal practice of providing a sputtering target. Different procedures of providing sputtering targets are provided, which result in various amounts of Ta and oxygen impurities. The Ta and oxygen impurities are not synthetically provided in the example sputtering targets. If the Examiner maintains this rejection, the Examiner is respectfully requested to explain what he intends by the term "intentionally added."

Further, the Examiner has provided no evidence or scientific basis to disqualify the objective evidence that Applicants have submitted establishing that the amount and dispersion levels of Ta and oxygen claimed are not inherent in Nb sputtering targets. If the Examiner maintains this rejection, the Examiner is respectfully requested to provide objective evidence and/or a scientific basis establishing that the amount and dispersion levels of Ta and oxygen claimed are inherent in Nb sputtering targets.

The claimed amounts and dispersion are not obvious in view of Ohhashi

The Ta and oxygen amounts and dispersion recited in claims 1 and 18 are not obvious in view of Ohhashi, in view of the fact that Ohhashi does not suggest that the Ta and oxygen amounts and dispersion are result effective variables for his Nb sputtering target. A particular parameter must first be recognized as a result-effective variable in order to show that a claimed range would have been obvious. See MPEP 2144.05 II B. In the present case, Ohhashi does not even recognize the existence of inevitable Ta or oxygen impurities in a Nb sputtering target, much less that such parameters are result effective variables. Thus, the recited Ta and oxygen amounts and dispersion in claims 1 and 18 are not obvious over Ohhashi for at least this reason.

Ohhashi fails to suggest the advantages of the claimed Ta and oxygen impurity levels with the claimed dispersion levels

Claims 1 and 18 are further seen to be patentable over Ohhashi in view of the advantages of the invention as claimed. Ohhashi fails to suggest these advantages, or to even recognize the parameters that are important in attaining these advantages. The inventors have determined important parameters in solving resistivity problems of Nb liner films for Al films. The present inventors have realized that merely decreasing the Ta or oxygen content alone does not decrease the resistivity of the entire Nb film with reproducibility. The inventors have found that, in high purity sputtering targets, the dispersion and content of Ta in the Nb target, and the dispersion and content of oxygen in the Nb target, are important parameters. These parameters are implemented in the sputtering targets of independent claims 1 and 18, which recite, respectively, the content and dispersion of Ta and the content and dispersion of oxygen, and the content and dispersion of oxygen which provide an improved Nb sputtering target. By suppressing the dispersion of Ta or oxygen in the Nb target, while at the same time decreasing the content of Ta or oxygen in the Nb target, it becomes possible to decrease the resistivity of the entire Nb wiring film, such as a film formed as a liner for an Al wiring film, when that film is formed using the sputtering target.

The beneficial effect of suppressing the dispersion of Ta or oxygen in the target to within the levels recited in claims 1 and 18 is demonstrated in the present specification, as noted throughout the prosecution of this application. Ohhashi completely fails to recognize or teach this key relationship that is the basis for the present invention directed to a Nb sputtering target, and consequently the reference does not and cannot render the present invention "obvious".

The dispersion of impurities in a Nb sputtering target exerts a large effect on the properties of an interconnection film formed using such a target. For example, when comparing targets No. 1 and 2 in Table 3 in the specification, the oxygen content thereof is very small to 10 ppm, which is less than 100 ppm, but there is a large difference in the wiring resistivity therebetween. That is, the resistivity of No. 1 having a dispersion of 82 % is 4.2μ Ω cm which exceeds 4.0 μ Ω cm. On the other hand, the resistivity of No. 2 having a dispersion of 40% is 3.0 μ Ω cm. As mentioned above, the dispersion of Ta or oxygen contained in Nb sputtering target has a large effect on the wiring properties in addition to the impurity content value in the Nb sputtering target. Thus, even if the impurity content is very small, when a dispersion thereof exceeds the range claimed, the characteristics of the interconnection film are deteriorated.

The Office Action on page 5, states as follows:

> Assuming arguendo that the Ta dispersion is non-uniform as targets 3 and 4 in instant Table A. The difference of resistivity of interconnection film is less than 3%. Thus, the claimed dispersion (%) has no criticality or unexpected result,

and on page 6:

> page 21 of instant specification, Table 1, targets 5 and 6 show that claimed dispersion (%) has not effect on resistivity of interconnection because targets 5 and 6 both have resistivity of interconnection way above targets 1-4.

Insofar as these statements in the Office Action suggest that the dispersion % of Ta and oxygen impurities has no effect on the resistivity of the interconnections, or that the advantages of the combination of the claimed impurities level and dispersion of Ta and

oxygen in a Nb sputtering target are not demonstrated by the examples, applicants respectfully disagree.

Comparing target No. 4 (example) with target No. 3 (comparative example), although target No. 4 has a Ta content of 2540 ppm, which is higher than No. 3 containing a Ta content of 1830 ppm, the resistivity of No. 4 (3.8 μΩ cm) is 0.1 μΩ cm lower than that of target No. 3 (3.9 μΩ cm). This is because No. 4 has a dispersion of Ta content within specified range of 30% (5%) which is lower than that of No. 3 (40%), even though the Ta content of No. 4 is higher than that of No. 3. Thus, even when the Ta content in the target is relatively high (No. 4), by suppressing the dispersion of Ta content, it is possible to obtain a film having a resistivity equal or lower than that of a film formed with a Nb target having a smaller Ta content.

Moreover, with respect to target No. 5, although the dispersion of Ta content is within the claimed 30%, its resistivity is 10.5 μΩ cm, much higher than 4.0 μΩ cm. This is because of the relatively larger Ta content exceeding the claimed 3000 ppm level. Thus, as can be seen from the examples, both a relatively lower Ta content as well as a relatively lower dispersion value are needed for lower resistivity.

In sum, in the Nb sputtering target containing Ta, which is difficult to separate from Nb, in order to decrease the effect of impurities, both (1) decreasing a Ta content to 3000 ppm or less, and (2) suppressing a dispersion of Ta content to within 30% are important. Thus, a Ta content of 3000 ppm or less can be tolerated as along as the dispersion is sufficiently low.

Analogous results are demonstrated in Table 3 for oxygen content and dispersion.

Claim 10

Claim 10 is directed to a Nb sputtering target and recites parameters concerning the grain diameter size of a Nb target that allows for suppressed occurrence of dust when sputtering. Claim 10, as amended, recites an average grain diameter of 100μm or less, a grain diameter in the range of 0.5 to 5 times an average grain diameter, and a dispersion of the grain size ratio of adjacent grains within 30%. The present inventors have found, based on

investigation of the occurrence of dust particles generated from Nb targets, that the occurrence of giant dust particles can be effectively suppressed for the grain diameter parameters recited in claim 10.

Ohhashi discloses a sputtering target having uniform microstructure and crystal orientations with crystal grain sizes of no more than 350 μm. However, Ohhashi fails to teach or suggest suppressing the occurrence of giant dust particles for sputtering. Therefore, Ohhashi fails to teach or suggest suppressing the occurrence of giant dust particles by controlling the grain size ratio of adjacent grains to be in the range of 0.5 to 5 and the dispersion of the grain size ratio of adjacent grains to be within 30%.

The Office Action continues to assert that the claimed grain size can be ranged from 10 to 1000 μm. Applicants again note this statement, aside from being incorrect, misses the point that Ohhashi does not suggest an <u>average</u> grain size less than 100 μm, or the advantages thereof in preventing dust. It is the <u>average</u> grain size as recited that provides advantages in reducing dust. Whether or not some of the larger grains (grains up to 1000 μm) fall within the scope of the grains in the Ohhashi target is irrelevant. Neither does Ohhashi recognize that the average grain size is important in reducing dust, nor does Ohhashi disclose the specific average grain size recited in claim 10. Ohhashi merely discloses a crystal grain size of no more than 350 μm.

The alleged APA also fails to suggest the parameters as recited in claims 1, 10 and 18, and thus fails to cure the deficiencies of Ohhashi.

For at least the reasons given above, applicants respectfully submit that claims 1, 10 and 18 are patentable over Ohhashi and the APA. Independent claims 24 and 25 include similar Ta and oxygen parameter limitations to claims 1 and 18, respectively, and are thus patentable for at least those reasons. All dependent claims depend from one of claims 1, 10, and 18, and are patentable for at least the same reasons, as well as for her patentable features recited therein.

<u>CONCLUSION</u>

In view of the foregoing amendments and remarks, Applicants respectfully submit that all of the pending claims are now in condition for allowance. An early notice to this effect is earnestly solicited. If there are any questions regarding the application, the Examiner is invited to contact the undersigned at the number below.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check or credit card payment form being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicants hereby petition for such extension under 37 C.F.R. §1.136 and authorize payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

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